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APOLLO MONTHLY PROGRESS REPORT
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NAS9-150

1 October 1963

Report Period

16 August to 15 September 1963

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PROGRAM MANAGEMENT

The Apollo flight test program was launched during the report period with the first booster qualification flight of the Little Joe II vehicle at WSMR (see Figure 1). Little Joe II boosted, to an altitude of about 24,000 feet, a dummy payload equivalent to the size, weight, and shape of the Apollo command and service modules and launch escape subsystem (LES). The dummy LES used for the flight was designed and manufactured by S&ID.

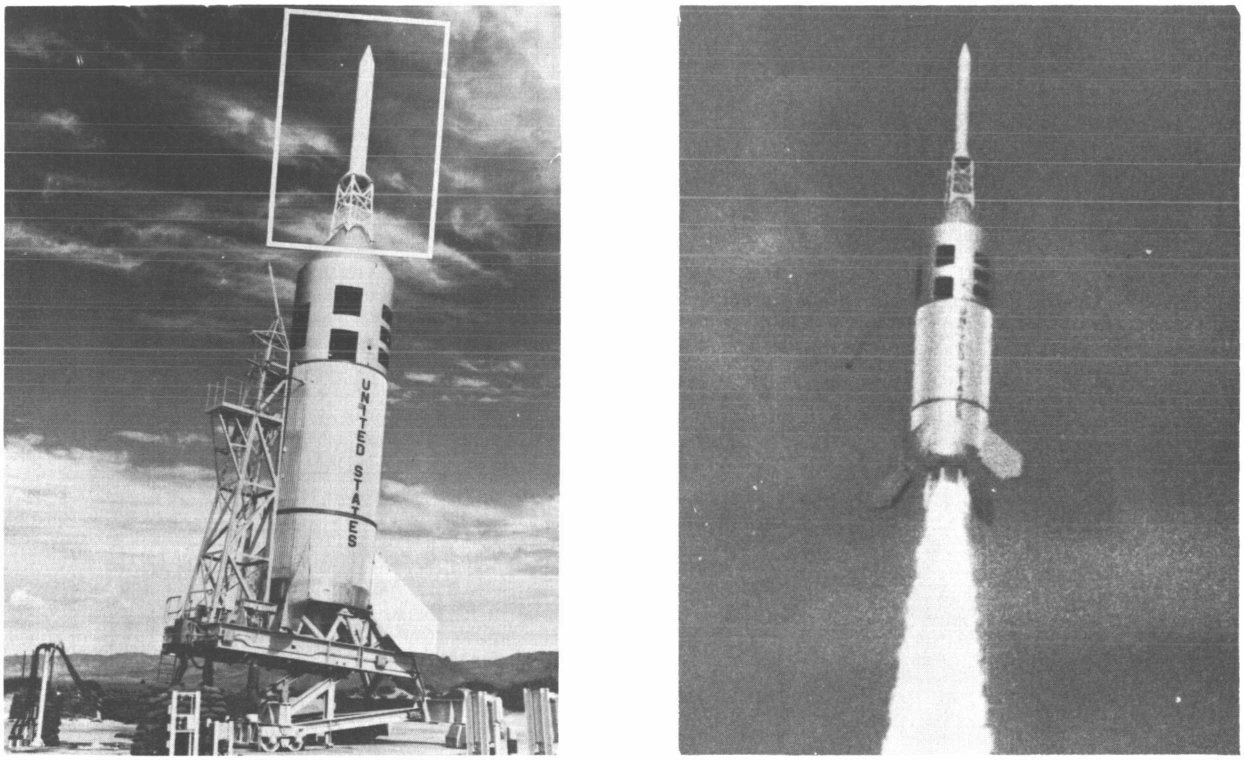

Figure 1. Little Joe II in Firing Position and in Flight

The Apollo parachute recovery system, successful in previous airborne drop tests, malfunctioned critically in a test at the El Centro facility. Boilerplate 3 was damaged on impact, and redesign of the parachute system will be necessary to ensure proper descent. This redesign effort may cause a delay in test operations.

At Downey, construction of the Systems Integration and Checkout Facility, the modification of Building 6, and construction of the Space Systems Development Facility adhered closely to schedule.

On 10 September approximately seventy NASA personnel inspected boilerplate 12 at S&ID before the boilerplate is shipped to WSMR for testing of the LES. Figure 2 shows boilerplate 12 being inspected by NASA personnel.

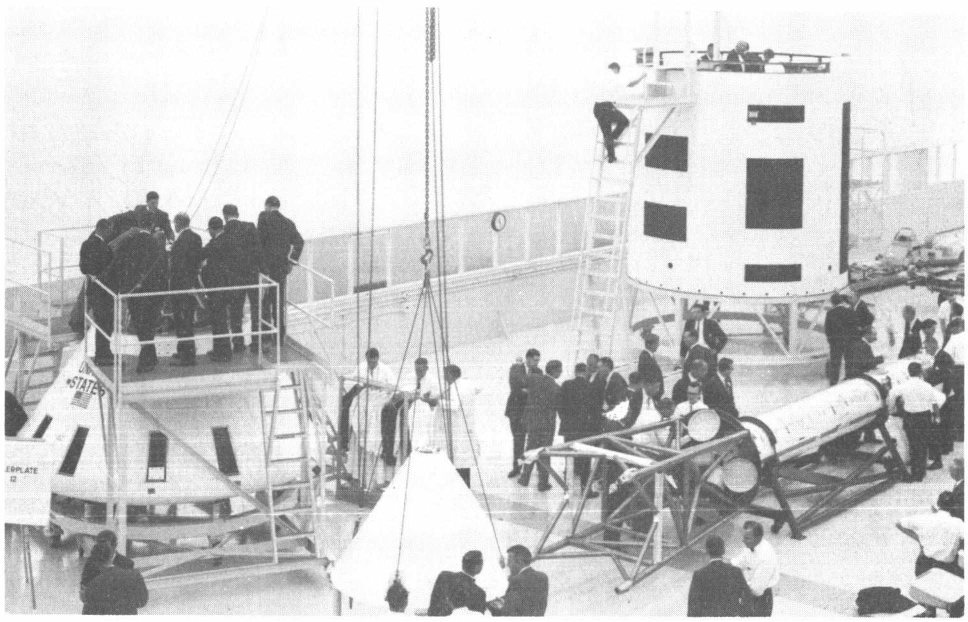

Figure 2. Design Engineering Inspection, 10 September 1963

On 11 and 12 September, approximately one hundred NASA personnel visited S&ID to review engineering designs of the complete Apollo spacecraft. As part of this review, mock-ups of the command and service modules and the LES were displayed; also on view were mock-ups of the navigation and guidance system and several items of equipment used by the astronauts. Because of the large number of visitors and the limited time available to cover the large scope of events, a new briefing technique using closed circuit television was employed to display current activities at S&ID.

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DEVELOPMENT

TECHNOLOGY

Flight Performance and Control

The results of studies simulating the impact docking mode of the command module with the lunar excursion module were analyzed. Manually-operated controls in a simulated command module cabin were connected electrically to an analog computer that positioned a TV camera to view the lunar excursion module as it would be seen by an astronaut through the left-hand docking window. The study simulated both the transposition and the backup lunar orbital phases for the impact docking concept. The design limits for transverse and closing velocities (0.5 feet per second and 1.0 feet per second, respectively) were not exceeded during the entire study for a nominal impact-type docking. The following conclusions were reached concerning subsystem operation:

1. The optimum trade-off between satisfactory pilot control and total propellant consumption is attained by a control system that includes rate command combined with attitude and rate feedback. Other rotational control subsystems studied included rate command with rate feedback only, acceleration command with no feedback, and minimum impulse acceleration command with no feedback.

2. The total propellant consumption of the service module reaction control subsystem (RCS) increases as the S-IVB attitude-hold limit cycle amplitudes or rates are increased. The smallest S-IVB amplitudes and rates compatible with optimum over-all propellant consumption for both S-IVB and service module RCS should be used.

3. Transposition and the backup lunar orbital docking maneuvers can be accomplished with a single-quad failure of the service module RCS; however, an increase in total propellant consumption amounting to 25 pounds and 16 pounds, respectively, will be required to accomplish these maneuvers.

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4. The flight director attitude indicator (FDAI) is useful to the pilot in maintaining attitude alignment after the astronaut has visually located the lunar excursion module. Other rendezvous displays of range, range rate, line of sight, and line-of-sight rate, however, appear to be of no benefit after the astronaut has visually located the target.

5. A three-dimensional target device mounted on the lunar excursion module, in conjunction with a sighting device in the command module, is required to satisfy the attitude accuracy requirements for visual alignment of the two vehicles.

6. A well defined change is necessary in the manual force required by the astronaut to operate the attitude hand controller when changing from the proportional to the emergency acceleration command mode. The astronaut must have instant knowledge of this change in modes to position the spacecraft accurately.

A set of spacecraft attitude orientation rules and criteria was developed and published. Principle elements affecting spacecraft attitudes during a lunar mission are grouped under the following major categories:

Safety and crew operations
Communications
Powered systems and trajectory
Nuclear radiation
Structures
Thermal considerations
Guidance and navigation
General

Thermal and Fluid Dynamics

The method for maintaining thermal control of each of the various service propulsion subsystem (SPS) items of equipment was determined. The RCS engines and tanks will be thermally controlled within required temperature limits by a water-glycol system and a heat source; a separate water-glycol system will provide the necessary thermal control for the SPS engine and tanks. Electrical or radioisotope heaters will provide heat directly to the SPS disconnect panel.

An analog computer program was developed to simulate transient performance of the service module RCS. The program determines surge pressure, propellant flow, and engine performance during engine start, normal operation, and shutdown modes. The firing of a single RCS engine or the simultaneous firing of two RCS engines can be simulated. A similar program is being developed for the command module RCS.

A thermal analysis is being made of the service module high-gain antenna boom during plume impingement of the service module RCS. A severe circumferential temperature variation exists on the boom surface ranging from 1400 F at the plume impingement point to 350 F at 180 degrees from this point. A thermal protection shield to reduce the high temperature of the RCS plume impingement is being investigated.

The C-band and telemetry antenna windows of boilerplate 22 require thermal protection to prevent window temperatures exceeding 250 F during the Little Joe II boost to a 60,000-foot altitude abort. Analysis shows that a 1/10-inch thick cork covering on the windows will maintain temperatures within design limits.

An analysis was completed of the temperature distribution in the command module heat shield surrounding the RCS nozzle extensions. In the immediate vicinity of the extension, the steady-state surface temperature varies from -178 F to 248 F; at 9 inches from the extension, steady-state temperatures vary from -260 F to 250 F.

Seven tower-flap configurations were tested on a static force model at AEDC at Mach number 6.0, and 23 configurations were tested in the NAA transonic wind tunnel at Mach number 3.5 to determine the optimum flap configuration that will eliminate the command module hypersonic secondary trim point. The selected configuration was further tested in the angle-of-attack range of 0 to 180 degrees at Mach numbers of 0.4, 1.2, and 3.5. Results of the analyses will be released during the next report period.

An extensive investigation was made to optimize wind tunnel instrumentation for a 1/10-scale command module model to be tested at the Ames Research Center during November. This model will be used to define the dynamic characteristics of the Apollo command module during tumbling, with and without the launch escape subsystem (LES) tower. A rotating device (photopot) will replace the slip rings and brushes. A camera and other equipment will be mounted on the photopot to provide angular position and velocity information over 360 degrees. This arrangement will furnish acceleration rates without introducing the frictional damping normally experienced with the use of slip rings and brushes.

Removal of the Freon system from the environmental control subsystem (ECS) was begun. Minor plumbing and valve changes in the water-glycol reservior will allow the reservoir to serve as a surge tank during the boost phase. The surge tank will contain ten pounds of water-glycol at 45 F and will adequately replace the Freon system. This change is expected to result in a net weight saving of 15 pounds and will eliminate control complications associated with the water boiler (heat exchanger).

Results of a study to investigate the cooling of electronic equipment indicate that three of the continuously operating pieces of equipment (inverter, electronic control assembly, and S-band transponder power amplifier) will exceed the required temperature limits unless supplemental cooling is used. Further studies indicate that it is feasible to maintain these three pieces of equipment at a constant base temperature, while the rest of the equipment continues under emergency conditions (complete loss of cooling); however, the means for achieving this supplemental cooling has not yet been defined.

Life Systems

Meetings with NASA are in progress to resolve problems and to detail S&ID support during the Johnsville centrifuge tests. Data recording problems were studied at a meeting held at AMAL, Johnsville, Pa.

The main display panel for the centrifuge fixture was successfully subjected to a 15-g load test. Weight and c.g. for the test fixture are being computed. Rework of the fixture to allow a three-axes load test to 15 g is nearly complete. The test fixture, display panel, and the instrumentation are completely assembled with the exception of the wiring required for instrument checkout. Delivery of the completed test fixture to AMAL is scheduled for early October.

Studies are in progress regarding post-impact crew survival techniques, in the open sea, including command module forced-air circulation and an apex inflatable flotation bag to assure an upright flotation position for the command module.

Investigations are being made of radiation effects on visibility through the exterior Suprasil quartz windows of the command module. Tests conducted by S&ID personnel at Oakridge Laboratory show that fluorescence occurs in the windows when subjected to electron and proton radiation. Suprasil exhibits less fluorescence, however, than other types of fused quartz. Resolution of the problem is under way.

Simulation and Trainers

The Apollo simulation program plan was presented to NASA-MSC-ASPO on 3 September for their evaluation preparatory to a joint review by S&ID and NASA. The program outlines flight phase and systems simulation as shown in Table 1:

Table 1. Simulation Program Plan

Simulation	Completed as of 1 September 1963	Total Program January 1962 to May 1965
	Flight Phase	
Entry	5	11
Boost and abort	2	9
Rendezvous	2	7
Coast and maneuver	4	10
Docking	3	7
	16	44
	Systems	
Attitude	1	9
Life systems	0 (1 in process)	8
Navigation sightings	0 (1 in process)	9
Propulsion	4	9
Reaction control system	1	5
Thrust vector control	7	15
	13	56
TOTALS	29	100

Current entry simulation activity includes preparation for the forthcoming centrifuge test at AMAL, Johnsville, Pa. The same computer program is to be used at AMAL that was used with engineering evaluator 1 for astronaut familiarization at S&ID. This preparatory simulation at S&ID accomplished two main goals: it provided complete checkout of mechanizations and systems prior to installation at AMAL, and it allowed astronaut familiarization and comparison of the evaluator controls and displays with the centrifuge test fixture.

Incorporation of all systems and computer mechanizations with the centrifuge controls and displays test fixture was completed at S&ID. This simulation employed the entry monitor display (EMD) and the flight director attitude indicator (FDAI) for primary display purposes. Astronaut evaluation was conducted on the centrifuge test fixture at S&ID, employing the systems used in engineering evaluator 1. System installation and mechanization at AMAL will begin on 1 October. Figure 3 shows the EMD and FDAI at the left-hand side of the command module main control panel.

Structural Dynamics

Recent land impact analyses and tests were concentrated on improving the crew couch attenuation struts. The use of step changes in the core diameters of the strut honeycomb structure to increase compression load strength progressively as the landing impact shock is absorbed by the couch struts appears to produce the best results for all possible landing conditions (see Figure 4).

Natural modes and frequencies of the lunar excursion module and command and service module configuration were calculated over a wide range of stiffness to study the problem of attaining a 40 radians per second first-mode frequency, which is desirable for stability of the control system. It was found that a factor of 10 increase in stiffness was needed on the lunar excursion module docking structure to obtain this frequency. Using the current design lengths for the lunar excursion module and command module tunnels, a factor of 4 increase in stiffness of the lunar excursion module structure and the command module tunnel is required. Studies are continuing on other approaches, including the shortening of the lunar excursion module tunnel to achieve a stiffer combined structure.

Initial analyses of the tethering mode of docking, using a constant line tension, appear promising. This concept requires the pilot to apply lateral thrust to align the contact points and uses a reel-in device to control contact velocity.

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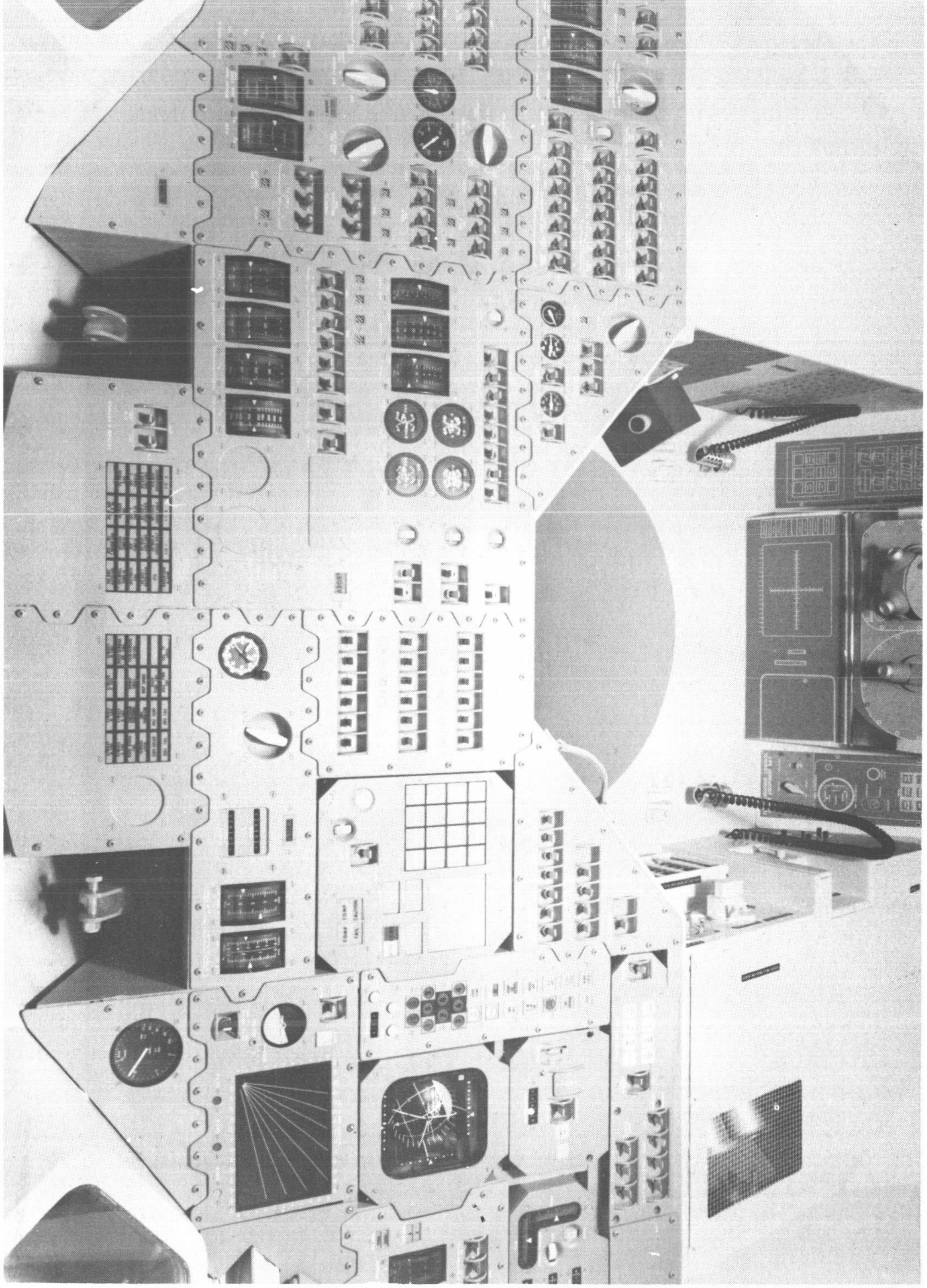

Figure 3. Command Module Main Control Panel

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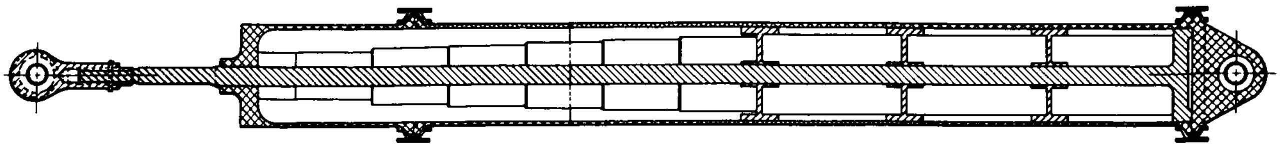

LENGTH: 31.66 INCHES NOMINAL; 48.50 INCHES EXTENDED

Figure 4. Crew Couch Attenuation Strut

Natural modes and frequencies were calculated to support load analyses for both the Saturn I and Saturn V vehicles. Eight free-free lateral bending modes were determined for the Saturn I study, and ten modes were computed for the Saturn V study. The latter study is concerned with launch loads, and the modes used represented the vehicle as tied down on the launch pad.

A structural segment of 180 degrees, simulating a section of the outer shell of the service module, was fabricated to investigate the probable response of the large curved honeycomb skin panels to acoustic excitation. The structure is now being instrumented and installed in a test chamber, and acoustic testing will begin during the next report period.

Vibration and acoustic measurements were reviewed and updated for spacecraft 002, 009, 010, and 011. The master measurement lists are being changed to account for recent modifications in vehicle configuration and to make the most effective use of the measurements in each flight.

SPACECRAFT AND TEST VEHICLES

Structures

Land impact drop tests 52, 53, and 54 were conducted on boilerplate 1 to study attenuation of the crew couch at impact in the y-y direction. All subsystems functioned satisfactorily, and the emergency tolerance limits were not exceeded.

Drop test 5 on boilerplate 3 was made to evaluate the earth landing system in support of boilerplate 6. The drop was made without side strakes or apex cover. Drogue descent, disconnect, and pilot mortar fire appeared normal. All three main parachutes ultimately failed, however, and the vehicle was damaged beyond repair at earth impact. The suspension lines of one pilot parachute were cut at deployment by contact with the vehicle, and the main parachute did not deploy, but remained on deck. The other two main parachutes were deployed normally by their pilots, but failed during the reefed condition due to damage in the upper vehicle harness. The first parachute finally deployed due to tumbling of the vehicle in flight, but failed because of the excessive load imposed by high dynamic pressure. A detailed investigation is being made, and the findings will be published in the next report.

Two LES tower tests were performed on static tower 1 to determine the ultimate load for pad abort and the maximum q for tumbling abort conditions. Test data are being evaluated, and the results will be released shortly. This tower will be subjected to a destruction test in the near future.

Operating mock-ups of the four proposed docking mechanisms are being designed and fabricated to evaluate four different concepts for docking the lunar excursion module with the command module. Initial testing has begun on an "air film" vehicle, supported by air streams from three pads, that will be used to simulate docking maneuvers during tests scheduled to begin in October.

Three of four Avcoat 5026-39 Scout nosecaps were delivered to NASA-Langley on schedule. The fourth nosecap will be delivered in October.

Five transition braze joint test pieces, made by brazing 304L stainless steel to 6061-T6 aluminum using a 12 percent silicon brazing alloy (AMS 4185), have successfully withstood a 10-day exposure to nitrogen tetroxide (N_2O_4) and Aerozine 50 fuels. Similar tests are now being run for a 40-day exposure period.

Guidance and Control

Development testing was conducted of the thrust vector control servo system incorporating the latest amplifier and actuator design. All testing employed inertial simulation equipment. Open loop testing to compare the actuator output force with the clutch differential current was completed; data are being analyzed, and a report will be made during the next report period. Closed loop testing showed the instability found previously at 18 cycles per second could be eliminated by removing the filters from the feedback networks. The system was tested using various amplifier feedback gains, and the results were compared with the spacecraft response criteria. The corner frequency of the closed loop system appeared to be about 15 radians per second as against the desired 20 radians per second. A test report will be issued during the next report period, and the results will be used to complete the design parameters for the guidance and control equipment.

A procurement specification revision is being prepared for release in October that will include the new Honeywell block diagrams and switching key tables. Fifteen up-dated specification control drawings and the installation drawings for spacecraft 001 and 009 will be released during September.

The problem of aligning the navigation base to the spacecraft is being resolved by the development of a three-axis optical alignment instrument. This device makes possible the measurement of angular positions about an orthogonal set of three axes, utilizing a single optical line of sight. Readings about all three axes were obtained to a 1σ accuracy of approximately 4-arc seconds, and further development is expected to improve this accuracy to about 1.5-arc seconds.

An analog study of the three-axis thrust vector control was completed. The study was made to determine whether roll control is necessary when the thrust vector control is operating and to study the effect of roll control on fuel consumption for minimum and maximum attitude deadbands. The following conclusions were reached:

1. Angular cross coupling is negligible without roll control.

2. The inertial velocity errors increase with time, and add extra vehicle position errors when roll control is off and when an initial roll rate condition exists.

3. Roll control should be left on during ΔV maneuvers.

4. The present system mechanization should be maintained.

Telecommunications

Elimination of the S-band transmitter output filter, used for restricting radio frequency transmitter bandwidth, is under investigation to reduce weight and decrease insertion losses of the unified S-band equipment. Results of this analysis should be available during the next report period, and recommenations will be transmitted to MSC.

S&ID is investigating the feasibility of using a service module-mounted VHF/2kmc omnidirectional antenna to replace the present antenna system on the command module. This study has been started to reduce aerodynamic effects and to improve the spacecraft weight distribution. A report will be presented to NASA during the next report period.

Failures during development testing of the traveling wave tube (TWT) resulted in a decision by the subcontractor to implement a backup program. The subcontractor has contracted for a klystron backup to the S-band TWT. The backup system offers potential advantages in simplification, less severe power supply requirements, reduced weight, and more rugged construction. The TWT problem areas were identified, and recent testing indicates this system can meet the requirements. The subcontractor will continue with the parallel development program through design verification testing.

The high-gain antenna contract was placed, and design is proceeding. Coordination is in progress of the changes to the system requirements due to increased heating rates.

Delivery of a central timing equipment evaluation model to S&ID is scheduled during the next report period. This evaluation model will be used at S&ID in component and subsystem evaluation tests.

The data storage equipment (DSE) design proof testing is in progress. Preliminary test records indicate no major DSE design problems. Proof testing will be complete in October.

Environmental Control Subsystem (ECS)

A warning system was added to signal possible malfunction of the ECS water separator accumulator. A very small rupture in the accumulator diaphram could leak oxygen into the water in the ECS, creating enough pressure so that both oxygen and water would be lost overboard through the water pressure relief valve. Also, an oxygen leak into the water in the ECS could build up enough pressure to reduce the effective storage capacity of the waste water tank. The warning system will enable the crew to isolate the malfunctioning unit and change over to the redundant ECS water separator accumulator to complete the mission successfully.

A back-pressure control valve was added to the ECS glycol evaporator steam discharge duct to provide a controlled rate of liquid boil-off (Freon or water). Previously, boil-off was controlled by a Freon/water inflow valve signalled by a water-glycol temperature sensor; ten minutes was required for saturation of the evaporant wick each time cooling was required. With the addition of the back-pressure control valve, water inflow is now controlled by a motor driven, timer dictated, shut-off valve. The timer permits 10 seconds of water inflow to the evaporator wick at 5-minute intervals unless it is sensed that water inflow is not necessary. Evaporation does not take place unless required, permitting the wick to be saturated constantly. Water is thus conserved, and wide temperature fluctuations are avoided.

Electrical Power Subsystem (EPS)

Pratt & Whitney Aircraft began assembling the first deliverable fuel cell. The assembly will consist of a stack of 31 fuel cells electrically connected in series. Tests indicate that problems exist due to shorted fuel cells and the presence of potassium hydroxide (KOH) electrolyte in the potable water output of the fuel cells. Corrective measures are being studied.

Pratt & Whitney has initiated fuel cell glycol corrosion tests, a-c impedance tests, and overload tests. All tests will be completed in October except for the second part of the corrosion test, which must run 800 hours.

All the 0.140-inch thick EPS radiator panels that were received in August have been rejected due to distortions generated during the rolling process. The use of thinner material (0.060 inches thick) is expected to eliminate this problem.

Functional tests on the complete pyrotechnic subsystems breadboard for boilerplate 6, including simulated malfunctions, were completed. Results were satisfactory, and a report is now being prepared for release during the next report period.

The design of the static inverter was frozen and production is now underway, with delivery scheduled for November. Several deviations were incorporated prior to the design freeze, including a weight increase of 8 pounds and an efficiency reduction of 2.5 percent. These changes were necessary to meet schedules.

Entry Monitor Display

A study was completed to determine an optimum g versus velocity (G versus V) display format for the entry monitor display (EMD). Over 200 simulated entries were made, using a computer that was programmed to simulate the Apollo guidance and navigation subsystem. The time required by the astronaut to recognize and react to an imminent skip-out was recorded for various entry trajectories, using each of the G versus V display formats to be tested. The simulations were for safe, marginally safe, marginal skip-out, and obvious skip-out trajectories. Several of the display formats selected from these tests will be studied further in the Johnsville centrifuge tests to determine the optimum format for high-g conditions.

A centrifuge model of the EMD unit was received for use in the Johnsville centrifuge tests. It has interchangeable display formats for the G versus V display and roll indications. This unit will be used to determine the optimum sizes and configurations for both types of displays,

Service Propulsion Subsystem (SPS)

During this report period, 194 test firings were made in the injector development program (see Table 2). Significant test results, using the prototype injector design (Doublet, POUL-31-10) with ablative chambers, were as follows:

1. The test demonstrated the capability of the prototype design of meeting the requirements of the Apollo mission duty cycle plus 241 additional seconds, accumulating a total of 910 seconds.

2. Fifty starts were made prior to a failure.

3. Three firings were made for a total of 861 seconds, using an oxidizer-to-fuel weight ratio of 2.2.

Three simulated altitude firings were conducted at AEDC. The first two firings were satisfactory, but the third firing was unsatisfactory due to injector leakage. Further tests are in progress.

The capillary reservoir in the SPS propellant tank was redesigned to provide propellant at the tank outlet for 5 seconds of firing under all mission modes.

A design engineering inspection of test fixture F-2 was conducted on 22 August. Twenty-five changes were requested; their disposition is in progress.

Contracts were completed for all SPS flight hardware components except for the helium solenoid valve. The contract for this item is under negotiation.

Table 2. Injector Development Test Program
Apollo Service Propulsion Engine

Serial Number	Pattern Type	Type of Evaluation	Number of Firings	Number of Unstable Firings	Total Time (sec)	Remarks
AFF-16	Doublet, POUL-31-10	Injector/acceptance test firings	3	0	41.5	Scheduled for installation on service module 005 engine
AFF-20	Doublet, POUL-31-10	C*	2	0	10.8	———
		Mixture ratio (MR) survey	5	1	871.0	861 seconds on ablative chamber at 2.2 MR
		Ablative checkout	1	0	30.9	Satisfactory
AFF-22	Doublet, POUL-31-10	C*	2	0	10.5	C* = 97.35 percent
		Stability	2	0	10.9	N_2 injection investigations
		Prototype determination	50	0	644.0	Forty-nine re-starts were conducted. On last firing, chamber burn-through occurred upstream of the throat.
AFF-24	Doublet, POUL-31-10	C*	5	0	28.2	C* - 96.2 percent
AFF-37	Doublet, POUL-31-10	C*	3	0	15.0	———
AFF-38	Doublet, POUL-31-10	C* stability	4	0	22.8	———
AEDC 1A	Engine	Simulated high altitude	3	0	15.0 (approx)	First and second firings were satisfactory. On the last firing, injector failure caused subsequent nozzle extension failure.
AEDC 2	Engine	Engine checkout	1	0	5.0	Satisfactory. Service module AFF-4 injector was installed.
		Acceptance test	1	0	30.7	Satisfactory
AFF-6	Doublet	C* pattern evaluation	3	0	15.4	———
AFF-11	Doublet, POUL-31-10	C* stability	1	1	1.0	Shutdown of combustion stability monitor—crack in oxidizer pie section
AFF-12	Doublet, POUL-31-10	C* stability	7	0	36.7	C* = 96.7 percent
		Prototype determination (ablative)	5	1	685.7	Abort duty cycle was demonstrated. Severe P_c oscillations were observed on one run.

Table 2. Injector Development Test Program
Apollo Service Propulsion Engine (Cont)

Serial Number	Pattern Type	Type of Evaluation	Number of Firings	Number of Unstable Firings	Total Time (sec)	Remarks
AFF-12	Doublet, POUL-31-10	Investigate pressure pulsations (without chamber)	33	0	450. 0	Eleven firings at MR = 1. 8 Eleven firings at MR = 2. 0 Eleven firings at MR = 2. 2 No pulsations were observed
		Alternate material	2	0	210. 0	Satisfactory
AFF-14	Doublet, POUL-31-10	C* stability	6	0	32. 9	Satisfactory
		Injector/chamber compatibility	2	0	240. 7	Satisfactory. Total time on ablative chamber was 910 seconds.
		Mission duty cycle	28	0	669. 3	Satisfactory
		Prototype determination	1	0	4. 0	Failure of fuel line manifold weld
AF-19	Doublet, POUL-31-11	C*	11	0	59. 0	C* = 97. 82 percent
		Injector/chamber compatibility	2	0	211. 0	Satisfactory
AF-20	Doublet	C* stability	2	0	11. 2	———
		Stability	4	1	16. 6	N_2 injection investigations
BF-19	Doublet, POUL-41-1	C* stability	3	0	17. 8	———
		Injector/chamber compatibility	1	0	200. 5	Satisfactory
BF-17	Doublet, POUL-31-3	C* stability	1	0	5. 9	Crack in baffle weld
FP-1	Flatplate	C* stability	3	2	3. 8	———

C* = Characteristic exhaust velocity

Use of a single helium coil appears satisfactory and designs were frozen on the helium-propellant heat exchangers.

Reaction Control Subsystem (RCS)

Flight weight RCS tanks will probably be replaced by ASME coded vessels as a safety measure for tests to be run on boilerplate 14 at S&ID.

Successful mission duty-cycle firings were completed for command module prototype engines 2007 without nozzle extension (after being cold-soaked at -200 F) and 2023 with nozzle extension (at ambient temperature). Engine 33 will be used for fuel depletion tests upon completion of the second half of the present mission duty-cycle firing.

The original service module prototype design RCS engines and the new 12-on-12 design engines were tested in plexiglass chambers, using both fuel and oxidizer leads. Monomethylhydrazine and Aerozine 50 were used as fuels. Tests are continuing to substantiate initial results and to explore the propellant lead-lag range with both high and low temperature propellants. Analysis shows that the fuel leads produce chamber pressures with about the same level of spikes as the oxidizer leads. Tests using cold (approximately 40 F) propellants have produced chamber pressures with high spikes even with no propellant leads. A detailed analysis of the data is in progress.

Marquardt completed the installation of propellant conditioning equipment in test cell 6, and tests are in progress to evaluate this system.

Launch Escape Subsystem (LES)

Studies of the propellant grain problem show that the accumulated water found in the failed LES motors was picked up primarily from moisture-laden air coming in contact with the solid fuel propellant. Future motors will be sealed after casting and during environmental testing, preventing contact of the propellant with the outside air. This action will prevent "breathing" of the motor and will effectively prevent moisture condensation on the inside of the motor.

Inspection of the LES motor for boilerplate 6 at WSMR revealed no evidence of moisture in the grain cavity, and the motor was reassembled, using fresh desiccant on the upstream side of the nozzle closures.

The first of the remaining three LES motors to be static fired in the development program was successfully fired during the report period. This was the first LES motor to be fired using hotwire igniter cartridges. The motor had been temperature cycled prior to firing, and desiccant bags had been bonded to the nozzle closure in the same manner as for boilerplate 6. All test objectives were met.

Five hydroburst tests of the tower jettison motor case were run, using 220,000 pounds per square inch (psi) tensile strength bolts, resulting in burst pressures ranging from 2690 to 2950 psi. The final hydroburst test was run on 3 September. All burst pressures provided a positive safety margin over the specification requirement of 2590 psi.

Modified igniter cartridges, using a different chemical mixture for the booster charge, have demonstrated lower peak pressure, slower burning, but higher caloric output in test firings at Space Ordnance Systems. Cartridges of this type are scheduled for immediate evaluation in pellet basket tests.

INTEGRATION

System Integration

During this report period, coordination meetings were held between S&ID and Grumman to provide Grumman with IBM 7094 and 1401 computer programs to assist them in compiling measurement requirement lists for the lunar excursion module. Grumman personnel were briefed on the uses and mechanics of the two computer programs and were provided with examples of measurement lists along with the procedures required for developing the lists. As a result of these coordination meetings and the data exchange, Grumman adopted the S&ID measurement approach and system.

The decision to make maximum use of air transport for shipment of Apollo hardware resulted in the development of engineering requirements and criteria for air transport as well as for the packaging and handling equipment required for this type of transportation. Standards are being developed and coordinated with NASA. To date, 1800 spares have been shipped to WSMR in addition to the major components of boilerplate 6 and associated GSE.

Test equipment is being readied for shipment to WSMR in preparation for electromagnetic interference (EMI) testing of boilerplate 6. This test is to determine compatibility of boilerplate 6 and associated GSE within the WSMR complex.

The S&ID interface control documents will be used at launch complex 37B for boilerplate 13 to validate all launch complex interfaces. This work will be accomplished by the joint effort of working groups from S&ID, ASPO, POD, MSFC, and LOC. The S&ID interface control documents contain the agreements made by S&ID (representing MSC) and the other NASA groups listed. This procedure will ensure compatibility of GSE hardware with the various subsystems of boilerplate 13.

Technical Operations

Certain changes will be made in boilerplate 6 to adapt it to the tower flap abort configuration required to accomplish the test objectives. The following changes will permit the apex cover to jettison with the LES tower during pad abort:

1. Removal of the command module side strakes
2. Deletion of the thruster pressure cartridge and rods
3. Deletion of the apex cover tension ties
4. Modification of the LES tower to accomodate tension-compression ties.

Note: There is no change in the sequencers or the ballast.

Supplemental spacecraft controls are required to provide the crew with the capability to maneuver the combined S-IVB-instrument unit—spacecraft vehicle while in earth orbit (for the purpose of orbit determination) and to allow use of the spacecraft guidance system as an alternative to ground control (for translunar injection guidance). These changes, requested on 22 August, include supplemental controls for the command module, service module, lunar excursion module, and S-IVB to be operated from the command module in earth orbit and through translunar injection, using the guidance and navigation and stabilization and control subsystem of the command module and the propulsion system of the S-IVB.

Command module mock-up 2 was updated to reflect the latest display panels, storage of loose equipment, side consoles, and guidance and navigation panels and was inspected by NASA at the design review meeting on 11 and 12 September. In addition, an updated service module and lunar excursion module were displayed to NASA.

The master spacecraft specification will be delivered to NASA in late September. This initial issue is consistent with the definitive contract baseline and includes the changes from contract change authorizations 1 through 32.

The present status of the interface control documentation, presented in Table 3, shows a total of 534 interface control documents (ICD) identified as of 15 September. Of this total, 14 are approved by NASA, 39 are approved by S&ID, and 14 of 127 applicable ICD's are approved by associate contractors. Of the 52 ICD's affecting MIT, 13 have received all necessary signature approvals, and 9 additonal ICD's were approved by S&ID only. The single ICD affecting Convair has all necessary signature approvals.

Changes in the document numbers between the last report period and this report are accounted for primarily by the consolidation of 7 ICD's into 1 for Convair and the reidentification of 25 NASA Inter-Center ICD's—23 as NASA Propulsion System Development Facility and 2 as NASA Mission Abort Facility.

Ground Support Equipment

Procurement specifications were completed and released for the ready storage units and fuel and oxidizer toxic vapor disposal units to be used in support of SPS test fixture F-2.

S&ID source inspection accepted the telemetry station from Arnoux, and NASA source inspection is in progress. Interference test procedures for EMI testing of the telemetry station were completed and transmitted to NASA.

The IBM tab cards were completely key-punched, and the production of the initial tapes was completed for the prelaunch automatic checkout equipment (PACE) system, including the command word generator tape programming. The analysis and flow charting for this program were completed. The coding, testing, and documentation of the PACE system will be complete during the next report period.

Design control specifications for the PACE-spacecraft response system were released. The procurement specification for the control system was released, and preliminary steps are being taken for procurement. Subsystem testing of the command and response breadboard systems is in process; system tests are scheduled to begin in September. Delivery of the breadboard is expected to be made on schedule in early October.

S&ID and Grumman began coordination efforts on common usage of the Apollo GSE. The first of several meetings planned was held at S&ID to

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Table 3. Interface Control Documentation Status Report
Through 15 September 1963

Associate Contractor	Total ICD's Identified	Approved by NASA	Approved by NAA	Approved by Associate Contractor
NASA (MSC) Electrical Systems Division	40	0	0	---
NASA (MSC) Crew System Division	1	0	0	---
NASA (MSC) AMRO	207	0	1	---
NASA (MSC) Propulsion System Development Facility	23	0	0	---
NASA (MSC) Mission Abort Facility	2	0	0	---
NASA Inter-Center	134	0	15	---
MIT	52	13	22	13
GD-Convair	1	1	1	1
Hamilton Standard	28	0	0	0
Grumman	46	0	0	0
TOTALS	534	14	39	14
Last Month's Totals	538	13	41	19

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review details of GSE for propulsion, RCS, and SPS for Apollo and the lunar excursion module. Other meetings are planned for discussions on GSE for electrical, communication and instrumentation, stabilization control, and environmental control subsystems for the lunar excursion module.

Reliability

The in-flight spares list for the electronic subsystems of spacecraft 011 was completed. Table 4 shows the approximate spares weight breakdown by subsystem.

Table 4. Spacecraft 011 Electronic Spares Requirements

Subsystem	Class I (lb)	Class II (lb)
Stabilization and control	22.5	8.2
Guidance and navigation	2.0	47.4
Communications and data	0	2.0
Total weight	24.5	57.6

Class I spares are those required to assure a safe abort in the event of failure of the originally installed item. Class II spares are those required to assure mission success.

Mission success probability, safe-abort logic diagrams, and the mission timeline of spacecraft 011 were used to conduct this study. Assuming that the other systems achieve apportioned objectives, and assuming the use of Class I spares only, the predicted reliability for spacecraft 011 mission is 0.945. To achieve the apportioned reliability of 0.984, Class II spares were varied to allow maximum improvement in mission success with minimum weight. Results of this study will be presented at the forthcoming spacecraft 011 reliability design review.

A study was performed to determine the effect of an in-flight test system (IFTS) on the reliability of Apollo electronics. Results indicate that the electronics reliability can be increased from 0.673 to 0.984 by using the IFTS (57 pounds) plus 86 pounds of spares.

Alternatives to an IFTS were analyzed to determine the weights necessary to achieve the required reliability. Redundancy of the electronic components within a subsystem and the "mass sparing" concept (wholesale sparing of all components making up the failed function without isolating the specific item) were analyzed to determine if either would be acceptable trade-offs to an IFTS. The results are shown in Table 5.

Table 5. Trade-Off Study Tabulation

Subsystem	Present Reliability	Reliability With Redundancy	Reliability With Mass Sparing	Reliability With IFTS and Spares
Communications and data	0.983	0.984	0.984	0.984
Guidance and navigation	0.880	0.976	0.976	0.976
Stabilization and control subsystem	0.809	0.990	0.990	0.990
Electronic subsystems	0.729	0.984	0.984	0.984*
Weight in pounds to achieve reliability		511	170	143
*Includes reliability of in-flight test system (0.9998)				

S&ID recommended to NASA that the IFTS and indicated spares be employed because of the weight advantages. The other approaches could result in schedule slips of 6 to 12 months.

Development of a specification covering all Apollo environmental design criteria is in process. This document, which will replace the existing requirements, incorporates the latest design criteria for use on the Apollo project, including revisions in temperature, vibration, acoustics, and shock. A new section will include data on rainfall and wind conditions at all test sites. Special criteria applicable to specific testing locations will be furnished. The release of this specification is expected in late September.

OPERATIONS

DOWNEY

All parts for the boilerplate 6 workstand were received, and the stand was completed and shipped to WSMR during the report period.

The flight-tracking data program for boilerplate 6 has been checked out, using a WSMR test tape, in preparation for the launch. The continuous telemetry data program digital tape has been checked out, and a new tracking program tape has been developed and checked.

On 20 August, an informal in-house development engineering inspection was held for boilerplate 12, and noted discrepancies were cleared. The formal NASA development engineering inspection was conducted on 10 September in the ATO test preparation area. The boilerplate was then returned to the assembly area for completetion of the modification program.

The signal conditioning boxes for boilerplates 13 and 23 have been modified and checked out. The boxes are now awaiting the NASA-supplied module cards.

Preparations for the development engineering inspection of boilerplate 13 are under way in the assembly area.

WHITE SANDS MISSILE RANGE

The following significant items of test preparation for boilerplate 6 were accomplished at WSMR:

1. The heat shield/escape tower modification has been completed. This modification will result in the apex heat shield being jettisoned with the launch escape tower. The command module strakes were removed upon receipt of authorization.

2. The adhesive bonding of the escape tower cables was completed. Both upper and lower vibration accelerometer mounts were removed from the escape tower for rebonding.

3. The pad adapter was installed and aligned on the ALA-3 launch pad. The launch pad area had been cleaned up after the Little Joe II booster vehicle qualification shot. The protective covering for the command module has been installed on the pad.

The structure housing the control center for the Propulsion System Development Facility (PSDF) test area has been completed and the interior work started. The tunnel has been completely back-filled, and the exterior of the GSE tunnel room is being waterproofed. In addition, the cooling water tank was completed, the fuel and oxidizer dump tanks are being installed, and the water-treatment plant walls are being formed and reinforced. Work was begun on the underground pipe lines for water and electricity, and mass excavation is in progress for test stand 2. Effort is continuing on the access roads, power lines, and power substations for the PSDF and water well.

ATLANTIC MISSILE RANGE

Work was completed for the preliminary additions to the Program Requirements document, covering requirements for spacecraft 009, 011, 012, 014, 015, 016, 018, 019, 020, 021, and 022. Preliminary copies of the document have been transmitted to NASA.

NASA-POD has agreed to the use of ducted cooling for all systems test units (STU) installations at AMR. This will result in raised floors in those facilities using STU's. The locations, power requirements, and fluids and gases to be utilized for launch complex 39 GSE were transmitted to NASA in support of a launch complex 39 meeting at Huntsville.

A discrepancy exists between S&ID process specifications and NASA-POD operational philosophy concerning the extent of launch escape motor inspection. NASA-POD desires to remove the aft cover for visual inspection of the propellant grain. S&ID needs a resolution of the grain inspection requirements for the boilerplate 13 launch escape motor.

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FACILITIES

DOWNEY

Systems Integration and Checkout Facility

Concrete slab construction for the first and second floors was completed. Two 15-ton bridge cranes were delivered and installed in the high-bay area; the air-conditioning compressors for the main system have been installed on their foundations. The strike of the duct insulators was settled on 11 September. The sprinkler pipe fitters remain on strike, with no predicted settlement date. The impact of these strikes on the construction schedule is under evaluation.

Building 6 Modification and Data Ground Station

Phase II of the Building 6 modification was completed. Phase III is scheduled for completion during the next report period. Negotiations are in progress on an amendment to the Data Ground Station contract for equipment cooling and electrical distribution work.

Space Systems Development Facility—Part I

The environmental control subsystem (ECS) portion of the building is approximately 90 percent complete. The main vacuum chamber is scheduled for delivery on 30 September. The contractor for the main building is erecting forms and reinforcing steel for the final pour of the cast-in-place walls.

Space Systems Development Facility—Part II

Roofing, interior partitions, and ceiling installations are complete. Mechanical equipment has been installed in the mechanical room. Completion of the building is scheduled for 27 September.

INDUSTRIAL ENGINEERING

An acceptable location for the pit-type Service Propulsion Pressure Test Facility has been established. A layout of the area has been prepared and is in the process of being approved. NASA approval to fund the cell has not been received.

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Planning has been completed for the acquisition of 22 additional trailers required to house Apollo Engineering.

Approximately seven hundred Engineering personnel were moved into the second floor of Building 6, following completion of Phase II modification of Building 6.

An analysis of facilities requirements for the manufacture of the S-IVB adapter has been completed. The relationship of production and facilities costs to alternate design configurations and manufacturing plans was developed as part of the analysis.

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APPENDIX

S&ID SCHEDULE OF APOLLO MEETINGS AND TRIPS

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S&ID Schedule of Apollo Meetings and Trips
15 August to 15 September 1963

Subject	Location	Date	S&ID Representatives	Organization
Hardware requirements meeting	Minneapolis, Minnesota	15-17 August	Guimont, Indlicato	S&ID, Control Data
GSE discussion	Houston, Texas	16 August	Altebernd, Duffy, Celia	S&ID, NASA
Boilerplate modification	WSMR	16-23 August	Gibbs, Nunn	S&ID, NASA
Distance realignment	WSMR	16-23 August	McGee	S&ID, NASA
Connector problems meeting	Minneapolis, Minnesota; Cedar Rapids, Iowa; Rolling Meadows, Illinois; Cambridge, Massachusetts	18 August	Calderon, Hopkins	S&ID, Minneapolis-Honeywell; S&ID, Collins; S&ID, Elgin; S&ID, MIT
Contract negotiations	Princeton, New Jersey	18 August	Kolb, Green, Anderson	S&ID, RCA-Astro Electronics Division
Electrical design problems discussion	East Hartford, Connecticut	18 August	Champaign	S&ID, Pratt & Whitney
Monthly coordination	Binghamton, New York	18 August	Hatchell, Dudek, Kerr	S&ID, GPI-Link Division
Engine test coordination	Tullahoma, Tennessee	18-20 August	Marchesini, Gunter	S&ID, AEDC
Astrodynamics conference	New Haven, Connecticut	18-21 August	Kakuske	S&ID, Yale University
Firings observation	Elkton, Maryland	18-21 August	Spencer, Charles, Strong	S&ID, Thiokol
Solid propellant problems meeting	McGregor, Texas	18-21 August	Bellamy	S&ID, NAA-Rocketdyne
Cryogenic conference	Boulder, Colorado	18-22 August	Corpening, Fisher, Ollodort	S&ID, Federal Bureau of Standards Cryogenic Engineering Laboratory; S&ID, University of Colorado
Parachute installation	WSMR	18-23 August	Byrd	S&ID, NASA
Service propulsion engine training program	Sacramento, California	18-30 August	Brown, Gordon, Milam, Kenyon, Littén, Kischer, Miller, Rivera, Poynor, Smith, Payne	S&ID, Aerojet-General
Boilerplate launch support	WSMR	19 August	McQullen	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips (Cont)
15 August to 15 September 1963

Subject	Location	Date	S&ID Representatives	Organization
Contract and scheduling meeting	Binghamton, New York	19 August	Frimtzis, Rogers	S&ID, GPI-Link Division
Funding forecast meeting	Minneapolis, Minnesota	19 August	Wessling, Molden	S&ID, Minneapolis-Honeywell
Negotiation and scheduling meeting	Binghamton, New York	19 August	Frimtzis, Rogers, Erickson, Mattei, Moir	S&ID, GPI-Link Division
Abort mode trim conditions	Houston, Texas	19-20 August	Osbon, Kehlet, Skene, Dodds	S&ID, NASA
Funding forecast meeting	Minneapolis, Minnesota	19-20 August	Wessling	S&ID, Minneapolis-Honeywell
Program review	Sacramento, California	19-20 August	Simkin	S&ID, Aerojet-General
Propulsion systems meeting	Houston, Texas	19-20 August	Kinsler, Chen	S&ID, NASA
Flight mechanics dynamics and control panel meeting	Houston, Texas	19-21 August	Yancey, Patterson, Nicholas, Tutt	S&ID, NASA
Subsystem design review	Cedar Rapids, Iowa	19-21 August	Page, Wixtrom, Whitanis, McCandless, Frost	S&ID, Collins
Heat shield discussion	Houston, Texas	19-23 August	Harris, Nicholas, Lundgren, Morant	S&ID, NASA
Purchase order entry	Alton, Illinois	19-23 August	Mason, Miller, Stefins	S&ID, Olin-Mathieson
Shop services and spares negotiations	East Hartford, Connecticut	19-25 August	Wermuth, Snyder	S&ID, Pratt & Whitney
Flight tests coordination	WSMR	19 August 9 September	Dunham	S&ID, NASA
Half-wave shorting problem discussion	Lima, Ohio	20 August	Champaign	S&ID, Westinghouse
NASA review	Sacramento, California	20-21 August	Cadwell	S&ID, Aerojet-General
Contract changes	Boulder, Colorado	20-23 August	Carter, White, Kinsigner, Bouman	S&ID, Beech Aircraft
Design review and analysis	Dayton, Ohio	20-23 August	Moreno, Errington	S&ID, United Aircraft
Monthly coordination	Indianapolis, Indiana	20-23 August	Westfall, Tapper, Brehaut, Tedisco, Peery, Milberger	S&ID, GM-Allison Division
Pretest conference	Mountain View, California	20-23 August	Crowder, Allen, Biss	S&ID, Ames

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S&ID Schedule of Apollo Meetings and Trips (Cont)
15 August to 15 September 1963

Subject	Location	Date	S&ID Representatives	Organization
Technical coordination	Sacramento, California	20-23 August	Borde	S&ID, Aerojet-General
Camera systems functional checkout	Houston, Texas	20-24 August	Dacus	S&ID, NASA
Boilerplate testing	El Centro, California	21 August	Pearce, Large, Streible, Kissler	S&ID, NASA, Naval Air Facility
Configuration and change procedure review	Houston, Texas	21-22 August	Templeton	S&ID, NASA
Trace contamination meeting	Houston, Texas	21-22 August	Clamcy	S&ID, NASA
Heat shield technical interchange meeting	Lowell, Massachusetts	21-25 August	Hanifin, Morant, Confer, Johnson, Nelson, Agustus, Gershun, Statham, Lowery	S&ID, Avco
BME coordination	Cedar Rapids, Iowa	21-29 August	Marine, Griffiths, Milham, Calvert	S&ID, Collins
GSE requirements review	Woodside, New York	21-29 August	Griffiths	S&ID, Avien
Preliminary pretest discussion	Mountain View, California	22-23 August	Takvorian, Vardoulis	S&ID, Ames
Blockhouse observer	WSMR	23-28 August	Bendees	S&ID, NASA
AIAA conference	Cambridge, Massachusetts	23-29 August	Canetti, Harthun	S&ID, MIT
System integration representation	WSMR	25 August	Lee	S&ID, NASA
Preliminary test plan meeting	Houston, Texas	25-26 August	Spengler, Huber	S&ID, NASA
Schedule discussion	Buffalo, New York; Elkton, Maryland	25-30 August	Hobson, Bevington, Whiting, Brent, Arnold	S&ID, Bell Aerosystems; S&ID, Thiokol
Design review conference	Sacramento, California	25-31 August	Beck, Briggs	S&ID, Aerojet-General
Wind tunnel tests	Hampton, Virginia	25 August 12 September	Gillies, Lundy	S&ID, Langley Research Center
ATO preparation	WSMR	25 August 20 September	Phillips	S&ID, NASA
Negotiations meeting	Sacramento, California	26 August	Bellamy, Field, Ross, Edwards, Beck, Farnus	S&ID, Aerojet-General
Space simulation and training meeting	Philadelphia, Pennsylvania	26 August	Cave	S&ID, American Psychological Association

S&ID Schedule of Apollo Meetings and Trips (Cont)
15 August to 15 September 1963

Subject	Location	Date	S&ID Representatives	Organization
LEM crew systems meeting	Bethpage, Long Island, New York	26-27 August	Smith, Cureton	S&ID, Grumman
Structural-mechanical systems meeting	Houston, Texas	26-27 August	Necker	S&ID, NASA
Communications and instrumentation subsystem panel meeting	Houston, Texas	26-28 August	Dwinell, Hall, Marks	S&ID, NASA
Contractual problems review	WSMR	26-28 August	Drucker, Lashbrook	S&ID, NASA
Flight crew procedures discussion	Houston, Texas	26-28 August	Wiggins, Stump	S&ID, NASA
Mission planning meeting	Houston, Texas	26-28 August	Miller, Steinwachs, Rosen	S&ID, NASA
Pressure suit meeting	San Diego, California	26-28 August	Waters	S&ID, Aviation Physiology Training Unit
Test support equipment meeting	WSMR	26-28 August	Kennedy	S&ID, NASA
Requirements review	Tarrytown, New York	26-30 August	Gibson, Bankson, Hindi	S&ID, Simmons Precision
Specification review and testing coordination	Minneapolis, Minnesota	26-30 August	Gibson, Hindi	S&ID, Minneapolis-Honeywell
Configuration control	WSMR	26 August 20 September	Kosovich	S&ID, NASA
GSE engineering support	WSMR	26 August 22 September	Marzolf	S&ID, NASA
Checkout panel meeting	AMR	27-28 August	McMullin, Gebhart, Cooper, Sobek, Overman, Richardson, Siwoly	S&ID, NASA
Docking interface coordination	Houston, Texas	27-28 August	Gustavson, Neatherlin	S&ID, NASA
Technical coordination	Sacramento, California	27-28 August	Borde	S&ID, Aerojet-General
Configuration control coordination	WSMR	27-29 August	Keyes	S&ID, NASA
Measurement list review	Houston, Texas	27-29 August	Wolff, Tomita	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips (Cont)
15 August to 15 September 1963

Subject	Location	Date	S&ID Representatives	Organization
Static inverter coordination	Lima, Ohio	27-29 August	Quabedeaux, Dudley, Dempsy	S&ID, Westinghouse
Test vehicle flight preparation	WSMR	27-29 August	Eich	S&ID, NASA
Failure effect analysis meeting	Huntsville, Alabama	27-30 August	Vucelic, Tutt	S&ID, NASA
Telemetry equipment test procedures coordination	Melbourne, Florida	27-30 August	Dorrell, Whitehead Schepak, Hourse, Hemond	S&ID; Radiation
GSE coordination	Bethpage, Long Island, New York	27 August 1 September	Cass, Doles	S&ID, Grumman
SCS meeting	Houston, Texas	27 August 9 September	Campbell, Webster	S&ID, NASA
Food program discussion	Palo Alto, California	28 August	Hair, Osborne	S&ID, Stanford Research Institute
Special testing support	WSMR	28 August	Solomon	S&ID, NASA
PERT schedules consultation	Binghamton, New York	28-30 August	Weizer, Matisoff	S&ID, GP-Link Division
Schedule review	Minneapolis, Minnesota	28-30 August	Dyson, Molden, Stiles	S&ID, Minneapolis-Honeywell
Facilities review	AMR	28-31 August	Porter, Mundy	S&ID, NASA
Grounding system checkout	Cocoa Beach, Florida	28 August 2 September	Fish	S&ID, NASA
Liaison meeting	Johnsville, Pennsylvania; Philadelphia, Pennsylvania	28 August 3 September	Hornick, Canby	S&ID, Naval Air Development Center; S&ID, Aviation Medical Acceleration Lab; S&ID, American Psychological Association
Contracts results presentation	Houston, Texas	29-30 August	Hagelberg, Pope, Albinger	S&ID, NASA
Negotiations meeting	Sacramento, California	29-30 August	Ross	S&ID, Aerojet-General
Trainer meeting	Houston, Texas	29-30 August	Marshall, Clark, Frimtzis, Steisslinger	S&ID, NASA
Markov processes discussion	Cambridge, Massachusetts; Boston, Massachusetts	30 August 4 September	Barry	S&ID, MIT; S&ID, Northeastern University
Parachute drop tests	El Centro, California	30 August 28 September	Trebes	S&ID, 6511th Test Group

S&ID Schedule of Apollo Meetings and Trips (Cont)
15 August to 15 September 1963

Subject	Location	Date	S&ID Representatives	Organization
Pressure test	Garland, Texas	2-5 September	Sumner	S&ID, Intercontinental Manufacturing
GSE support	WSMR	2-28 September	Schneider	S&ID, NASA
Digital computer reevaluation	Houston, Texas	3-4 September	Dudek, Barnett, Furlong, Premo, Kerr	S&ID, NASA
Flight technology systems meeting	Houston, Texas	3-4 September	Dodds, Harthun, Lundgren, Statham	S&ID, NASA
GSE common usage	Downey, California	3-4 September	Richardson, Corvese	S&ID, NASA, Grumman
Acceptance testing	Metuchen, New Jersey	3-5 September	Kluth	S&ID, Applied Electronics
Engineering meeting	Cedar Rapids, Iowa	3-5 September	Percy, MacGregor, Barrier	S&ID, Collins
Failure effect analysis and flight dynamics review	Huntsville, Alabama	3-5 September	Vucelic, Pringle	S&ID, NASA
Second tier subcontractor	Cleveland, Ohio	3-5 September	Briggs, Leffler, Field, White, Borde	S&ID, Lear Siegler
Titanium pressure vessel design coordination	Boulder, Colorado	3-5 September	Bouman, Dupaquier, Bojic	S&ID, Beech Aircraft
C-band transponder review	Paramis, New Jersey	3-6 September	Kronsberg	S&ID, ACF Electronics
Engine testing and design coordination	Sacramento, California	3-6 September	Mower	S&ID, Aerojet-General
Fuel cell tests	Hartford, Connecticut	3-6 September	Holmes	S&ID, Pratt & Whitney
Installation design review	Cambridge, Massachusetts	3-6 September	Beck, Rose, Archer	S&ID, MIT
Contract negotiations	Melville, Long Island, New York	3-7 September	Webb, Brooks, Shaw, Commins	S&ID, Cutler-Hammer; S&ID, Airborne Instrumentation Lab
SCS weights coordination	Minneapolis, Minnesota	3-8 September	Gasparre, Frost	S&ID, Minneapolis-Honeywell
Boilerplate support preparation	WSMR	3-17 September	Wolff, Mattson	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips (Cont)
15 August to 15 September 1963

Subject	Location	Date	S&ID Representatives	Organization
System trainers meeting	San Diego, California	4 September	Hanlon, Elderkin	S&ID, U.S. Naval Air Station
Signal conditioning equipment design problems	Cambridge, Massachusetts; Southampton, Pennsylvania	4-5 September	Himmelberg, Barrier	S&ID, EPSCO; S&ID, Vector Manufacturing
Configuration management briefing	Houston, Texas	4-6 September	Templeton, Karl, Highland, Lopatin	S&ID, NASA
Crew provisions installations	St. Louis, Missouri	4-6 September	Brockman, Tarr	S&ID, McDonnell
Engineering schematics meeting	WSMR	4-6 September	Maranjo	S&ID, NASA
Measurement requirements meeting	Houston, Texas	4-6 September	Eckmeier, Boothe	S&ID, NASA
Quality control coordination	Bethpage, Long Island, New York	4-6 September	Griffith-Jones	S&ID, Grumman
Facility survey	Pompano Beach, Florida	4-7 September	Hardaway, Leonard, Wolcott	S&ID, Hoover
Technical design discussion	Southampton, Pennsylvania	4-7 September	Sturkie	S&ID, Vector
Washington confinement study review	Seattle, Washington	4-8 September	McCarthy, Stoll, Brewer, Sofios, Easton	S&ID, Boeing
Parachute drop tests	El Centro, California	4 September 2 November	Young, Duffy	S&ID, Naval Air Facility
Man-rated tests presentation	Houston, Texas	5-6 September	Sheere, Pass, Wingo, Hair	S&ID, NASA
Technical review	College Park, Maryland	5-8 September	McCabe	S&ID, LS-Radcom-Emertron
Engineering representative	Boulder, Colorado	5-20 September	Myer	S&ID, Beech Aircraft
Coatings and transmittance discussion	Santa Rosa, California	6 September	Olessen	S&ID, Optical Coating Labs
Drop tests evaluation	El Centro, California	6 September	Necker, Rodier, Goble	S&ID, Naval Air Facility
Field weight functions	WSMR	6 September	Sheeley	S&ID, NASA
Design review	Minneapolis, Minnesota	6-11 September	Dyson, Maxwell, Antletz, Gibson, Mallon, Stiles, Molden	S&ID, Minneapolis-Honeywell

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S&ID Schedule of Apollo Meetings and Trips (Cont)
15 August to 15 September 1963

Subject	Location	Date	S&ID Representatives	Organization
Sextant and telescope meeting	Cambridge, Massachusetts	6-11 September	LaFrance, Benson, Fatton	S&ID, MIT
High-gain antenna resolution	Woodside, New York	6-13 September	Womack, Ilinski	S&ID, Avien
Technical papers presentation	Paris, France	6 September 7 November	Chatelain	S&ID, International Congress of Astronautics
Radio warning study	Boulder, Colorado	8 September	Wernick, Thomas	S&ID, National Bureau of Standards
Specification negotiation	Woodside, New York	8 September	Greenfield, Kerr	S&ID, Avien
Documentation and proposal clarification	Scottsdale, Arizona	8-9 September	Shear	S&ID, Motorola
Funding review	Minneapolis, Minnesota	8-11 September	Rothacher	S&ID, Minneapolis-Honeywell
Parachute installation	WSMR	8-11 September	Manha	S&ID, NASA
PERT networks development	AMR	8-11 September	Toppel, McKinney	S&ID, NASA
Supplier survey	Minneapolis, Minnesota; Falls Church, Virginia; Melbourne, Florida	8-11 September	Greenfield, Schwarzman	S&ID, Control Data Corporation; S&ID, Melpar; S&ID, Radiation
Monthly coordination	Hartford, Connecticut	8-12 September	Nash, Alpert, Jorgensen	S&ID, Pratt & Whitney
Electrical wiring checkout	WSMR	8-21 September	Clyde	S&ID, NASA
Wind tunnel tests	Tullahoma, Tennessee	8-21 September	Daileda	S&ID, AEDC
GSE meeting	Houston, Texas	9-10 September	Richardson, Embody, Fallico, Stopler, Hadsall	S&ID, NASA
Pretest conference	Mountain View, California	9-10 September	Davey, Gordon, Critechley	S&ID, Ames
Contract coordination	AMR	9-11 September	Drucher, Maleck	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips (Cont)
15 August to 15 September 1963

Subject	Location	Date	S&ID Representatives	Organization
Spacecraft mission trajectory meeting	Houston, Texas	9-11 September	Rider, Kakuske, Meston	S&ID, NASA
Specification interpretation	Boulder, Colorado	9-11 September	Nichols	S&ID, Beech Aircraft
Fuel cell and test facility meeting	Coca Beach, Florida	9-12 September	Margetan, Davis, Wechsler, Grosch, Smith, Yancey	S&ID, NASA
Fuel cell research progress	Indianapolis, Indiana	9-12 September	VanCamp, Symons	S&ID, Allis Chalmers
GSE provisioning and spares negotiation	Houston, Texas	9-12 September	Coulson	S&ID, Office City
Engineering liaison	WSMR	9-13 September	Teter, Fisher	S&ID, NASA
Monthly coordination	Hartford, Connecticut	9-13 September	VanCamp, Wermuth, Symons, Rood	S&ID, Pratt & Whitney
Monthly design meeting	Melbourne, Florida	9-13 September	Britton, Rutkowski, Baldwin, Crossfield, Shadwick	S&ID, Radiation
Resident replacement	Newbury Park, California	9-13 September	Safford	S&ID, Northrop-Ventura
Technical coordination	Sacramento, California	9-13 September	Borde	S&ID, Aerojet-General
Technical coordination and design review	Downey, California	9-13 September	Brown	S&ID, Collins
Electrical power system meeting	Bethpage, Long Island, New York	9-14 September	Corvese, Fisher, Bretherton	S&ID, Grumman
Representative relocation	Sacramento, California	9-20 September	Beck	S&ID, Aerojet-General
GSE support	WSMR	9 September 5 November	Frank	S&ID, NASA
GSE meeting	Downey, California	10-11 September	Todd, Kasten	S&ID, MIT
ICD coordination	Downey, California	10-11 September	Gustavson	S&ID, Grumman
LEM test panel meeting	Houston, Texas	10-11 September	Severine, Gilbert	S&ID, NASA
Crew safety system panel	Houston, Texas	10-12 September	Vucelic	S&ID, NASA
GSE common usage	Downey, California	10-12 September	Richardson, Lane	S&ID, Grumman

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S&ID Schedule of Apollo Meetings and Trips (Cont)
15 August to 15 September 1963

Subject	Location	Date	S&ID Representatives	Organization
Human factors subcommittee	Washington, D. C.	10-12 September	Rabideau	S&ID, Electronic Industries
Specification review	Phoenix, Arizona	10-12 September	Hall, Chiavacci	S&ID, Motorola
Test fixture review	WSMR	10-12 September	Gatewood	S&ID, NASA
Proposal negotiations	Sacramento, California	10-13 September	Briggs, Flynn, Colston, Leffler, White	S&ID, Aerojet-General
GSE systems meeting	Houston, Texas	11 September	Embody, Moore	S&ID, NASA
Electrical integration panel meeting	Houston, Texas	11-12 September	Turk, Crawford, Robinson	S&ID, NASA
Evaluator review	Minneapolis, Minnesota	11-12 September	Susser	S&ID, Minneapolis-Honeywell
GSE coordination	Scottsdale, Arizona	11-12 September	Kolb	S&ID, Motorola
Test and operations field site familiarization	WSMR	11-12 September	Harvey, Mazur	S&ID, NASA
Design and weights review	Sacramento, California	11-13 September	Cadwell, Klitsche	S&ID, Aerojet-General
GFP procurement procedures	WSMR	11-13 September	Coulson, Parsons	S&ID, NASA
Navigation and guidance meeting	Houston, Texas	11-13 September	Kennedy, O'Malley, Niemand, Henley, Lundy	S&ID, NASA
Revised program definition	Sacramento, California	11-13 September	Field	S&ID, Aerojet-General
Design review	Wilmington, Massachusetts	11-14 September	Gershun, Statham	S&ID, Avco
Radiator panels design and checkout	Louisville, Kentucky	11-14 September	Daoussis, Miller, Mason	S&ID, Reynolds Metals
Coordination meeting	Sacramento, California	12-13 September	Bellamy, Simkin, Borde	S&ID, Aerojet-General
Engineering coordination	Tarrytown, New York	12-13 September	Ryan	S&ID, Simmonds Precision
Fact-finding survey	Banning, California	12-13 September	Malanczuk	S&ID, Deutsch

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S&ID Schedule of Apollo Meetings and Trips (Cont)
15 August to 15 September 1963

Subject	Location	Date	S&ID Representatives	Organization
Fuel cell program review	Hartford, Connecticut	12-13 September	Nelson	S&ID, Pratt & Whitney
Technical coordination	Downey, California	15 September	Jensen	S&ID, Minneapolis-Honeywell
Training class meeting	Cedar Rapids, Iowa	15-16 September	Walterscheid	S&ID, Collins
Fact-finding meeting	Sunnyvale, California	15-17 September	Travis, Langeley	S&ID, Thermatest Laboratories
Gamma probe study discussion	New York City, New York	15-17 September	Laubach, Raymes	S&ID, United Nuclear
Technical discussion	Palo Alto, California	15-17 September	Travis, Langley	S&ID, Palomar Scientific